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01/08/2008 03:43 PM

To Dan Meyer/R10/USEPA/US@EPA, Herman
Wong/R10/USEPA/US@EPA
cc "Shell - Susan Childs" <Susan.Childs@shell.com>, "PB -
Susan Mathiascheck" <smathiascheck@pattonboggs.com>,
"AES - Gene Pavia" <gene.pavia@asrcenergy.com>
bcc

Subject Kulluk emission spreadsheet

History:



This message has been forwarded.

Dan and Herman, the emissions and modeling input parameter spreadsheets are attached. For your use in working through the development of our numbers in the impact report.

Rodger



SOI_Emissions_01082008.xls



Air Sciences Inc.

ENGINEERING CALCULATIONS

PROJECT TITLE:		BY:	
Shell Offshore, Inc.		R. Steen	
PROJECT NO:		PAGE:	OF:
180-15-1		1	8
SUBJECT:		DATE:	
Shell Kulluk Emissions		December 31, 2007	

Sources - Draft Permit R10OCS-AK-07-01 (Kulluk)				Max fuel consumpt. per hour (mBtu/hr)	Max Emissions (lb/hr) PM ₁₀ NO _x
Shell Kulluk					
K-1	A1	Generator	EMD / unknown	2,816 hp	19.712 1.129 42.2 ***
K-2	A1	Generator	EMD / unknown	2,816 hp	19.712 1.129 42.2 ***
K-3	A1	Generator	EMD / unknown	2,816 hp	19.712 1.129 42.2 ***
K-4	A3	Emergency Gen	Unknown	920 hp	6.440 0.369 30.7 *
K-5	A3	Air Compressor	Hydraulic	500 hp	--- 0.000 0.0
K-6	A3	Air Compressor	Hydraulic	500 hp	--- 0.000 0.0
K-7	A3	Air Compressor	Hydraulic	500 hp	--- 0.000 0.0
K-8	A3	Deck Crane	Mercedes/OM404	293 hp	2.051 0.316 9.8
K-9	A3	Deck Crane	Mercedes/OM404	293 hp	2.051 0.316 9.8
K-10	A3	Deck Crane	Mercedes/OM404	293 hp	2.051 0.316 9.8
K-11	A3	Thrustmaster	Caterpillar/3516 B	2,000 hp	14.000 0.802 66.8 **
K-12	A3	Thrustmaster	Caterpillar/3516 B	2,000 hp	14.000 0.802 66.8 **
K-13	A3	HPP Engine	Unknown	320 hp	2.240 0.346 10.7
K-14	A3	HPP Engine	Unknown	320 hp	2.240 0.346 10.7
K-15	A2	Heat Boiler	Unknown	2.4 mBtu/hr	2.400 0.370 0.4
K-16	A2	Heat Boiler	Unknown	2.4 mBtu/hr	2.400 0.370 0.4
K-17	A2	Hot Water Heat	Unknown	0.54 mBtu/hr	0.540 0.083 0.1
K-18	A2	Hot Water Heat	Unknown	0.54 mBtu/hr	0.540 0.083 0.1
K-19	K	Incinerator	TeamTec/GS500C	276 lb/hr	0.966 0.4
total while drilling				110	5.32 135.92

* Emergency use only.

** Emissions are permit-limited to 1 engine running at capacity

*** Emissions are permit-limited to the equivalent of 2 engines running at capacity

Values in blue are input.

Values in black are calculated.



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				Max fuel consumpt. per hour (mBtu/hr)		Max Emissions (lb/hr) PM10 NOx	
Sources - Draft Permit R10OCS-AK-07-01 (Kulluk)							
Vladimir Ignatjuk (icebreaker)							
VI-1	B1	Main Propulsion	Wärtsilä / 9ZL	5,800	hp	40.600	2.326 134.8
VI-2	B1	Main Propulsion	Wärtsilä / 9ZL	5,800	hp	40.600	2.326 134.8
VI-2	B1	Main Propulsion	Wärtsilä / 9ZL	5,800	hp	40.600	2.326 134.8
VI-4	B1	Main Propulsion	Wärtsilä / 9ZL	5,800	hp	40.600	2.326 134.8
VI-5	B2	Generator Engine	Wärtsilä / 9ZL	1,431	hp	10.017	0.574 33.3
VI-6	B2	Electrical Generator	Wärtsilä / 9ZL	1,431	hp	10.017	0.574 33.3
VI-7	B3	Heat Boiler		2.4	mBtu/hr	2.400	0.057 0.4
VI-8	B3	Hot Water Heater		0.54	mBtu/hr	0.540	0.013 0.1
VI-9	K	Incinerator		66	lb/hr		0.231 0.1
VI total				185		10.8 606.4	
Tor Viking II (icebreaker)							
TV-1	C1	Main Prop	MaK 8M32	5,046	hp	35.322	2.023 28.6
TV-2	C1	Main Prop	MaK 8M32	5,046	hp	35.322	2.023 28.6
TV-3	C1	Main Prop	MaK 6M32	3,784	hp	26.488	1.517 21.5
TV-4	C1	Main Prop	MaK 6M32	3,784	hp	26.488	1.517 21.5
TV-5	C2	Harbor Generator	Caterpillar 3412	1,168	hp	8.176	0.468 4.2
TV-6	C2	Harbor Generator	Caterpillar 3412	1,168	hp	8.176	0.468 4.2
TV-7	C3	Heat Boiler		1.37	mBtu/hr	1.370	0.032 0.2
TV total				141		8.1 108.8	
Jim Kilabuk (re-supply vessel)							
JK-1	D	Main Propulsion	EMD / V20 645	3,600	hp	25.200	1.444 120.3
JK-2	D	Main Propulsion	EMD / V20 645	3,600	hp	25.200	1.444 120.3
JK-3	D	Generator	Cat / D3406	292	hp	2.044	0.642 9.8
JK-4	D	Generator	Cat / D3406	292	hp	2.044	0.642 9.8
JK-5	D	HPP Engine	Cat / D343	300	hp	2.100	0.660 10.0
JK-6	D	Bow Thruster	Cat / D343	300	hp	2.100	0.660 10.0
JK total				58.7		5.49 280.16	



Air Sciences Inc.

ENGINEERING CALCULATIONS

PROJECT TITLE: Shell Offshore, Inc.		BY: R. Steen	
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SUBJECT: Shell Kulluk Emissions		DATE: December 31, 2007	

Sources - Draft Permit R10OCS-AK-07-01 (Kulluk)					Max fuel consumpt. per hour (mBtu/hr)	Max Emissions (lb/hr) PM ₁₀ NO _x	
Nanuq (Main Oil Spill Response Vessel)							
N-1	E	Propulsion Engine	2,710	hp	18.970	1.087	65.4
N-2	E	Propulsion Engine	2,710	hp	18.970	1.087	65.4
N-3	E	Generator	1,285	hp	8.995	0.515	31.0
N-4	E	Generator	1,285	hp	8.995	0.515	31.0
N-5	E	Emergency Gen	1,285	hp	8.995	0.515	31.0 **
N-6	E	Boiler	3.2	mBtu/hr	3.200	0.076	11.0 *
N-7	K	Incinerator ASC / CP100	125	lb/hr		0.438	0.2
N total					68.125	3.717	203.905
Kvichak No. 1 34-foot Oil Spill Response Work Boat							
1	E	Propulsion	300	hp	2.100	0.660	7.2
2	E	Propulsion	300	hp	2.100	0.660	7.2
3	E	Generator	12	hp	0.084	0.026	0.3
K total					4.284	1.346	14.759
Kvichak No. 2 34-foot Oil Spill Response Work Boat							
1	E	Propulsion	300	hp	2.100	0.660	7.2
2	E	Propulsion	300	hp	2.100	0.660	7.2
3	E	Generator	12	hp	0.084	0.026	0.3
					4.284	1.346	14.759
Affinity (Arctic tanker & oil spill response vessel)							
AP-1	E	Propulsion B&W / 7S60MC	15,820	kW	148.392	8.501	511.2
AP-2	E	Generator P B&W / 7L23	1,120	kW	10.506	0.602	36.2
AP-3	E	Electrical C B&W / 7L23	1,120	kW	10.506	0.602	36.2
AP-4	E	Generator S B&W / 7L23	1,120	kW	10.506	0.602	36.2
AP-5	E	Em Generator NT855	295	kW	2.767	0.870	9.5 **
AP-6	E	Power Pack KTA19	477	kW	4.474	1.406	15.4
AP-7	E	Power Pack KTA19	477	kW	4.474	1.406	15.4
AP-8	E	Power Pack KTA19	477	kW	4.474	1.406	15.4
AP-9	E	Auxiliary Boiler MB07S01	85	mBtu/hr	85	2.006	292.8
AP-10	K	Incinerator OG 400	188	lb/hr		0.658	0.3
					281.1	17.19	959.2
total OSR fleet						23.60	1192.63



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Shell Kulluk Emissions

DATE:

December 31, 2007

Emission Factors and Conversions

Conversions

7,000 Btu/hp-hr
0.007 mBtu/hp-hr
0.1370 mBtu/gal
1.340 hp/kW
454 g/lb
3600 sec/min

Diesel Fuel sulfur content

0.19% by wt.
7.05 lb/gal
2 wt. conversion of S to SO₂
0.196 lb/mBtu - all engines except < 600 hp on drill vessel
0.05% by wt.
0.051 lb/mBtu - < 600 hp on drill vessel

NO_x Factors - Generic (from permit R100CS-AK-07-01, and converted at 137,000 Btu/gal)

Group Description	Group	EF	EF
Kulluk electrical generators	A1	0.293 lb NO _x / gal	2.1387 lb/mBtu
Kulluk boilers/hot water heaters	A2	0.02 lb NO _x / gal	0.146 lb/mBtu
Kulluk remaining sources	A3	0.654 lb NO _x / gal	4.7737 lb/mBtu
Vladimir Ignatjuk main prop	B1	0.455 lb NO _x / gal	3.3212 lb/mBtu
Vladimir Ignatjuk main generators	B2	0.455 lb NO _x / gal	3.3212 lb/mBtu
Vladimir Ignatjuk boilers	B3	0.02 lb NO _x / gal	0.146 lb/mBtu
Tor Viking II prop generators	C1	0.111 lb NO _x / gal	0.8102 lb/mBtu
Tor Viking II harbor generator	C2	0.071 lb NO _x / gal	0.5182 lb/mBtu
Tor Viking II boiler	C3	0.02 lb NO _x / gal	0.146 lb/mBtu
Jim Kilabuk sources	D	0.654 lb NO _x / gal	4.7737 lb/mBtu
Oil Spill Response Fleet sources	E	0.472 lb NO _x / gal	3.4453 lb/mBtu
Incinerator		0.0015 lb/lb	AP42 (Table 2.1-12, 10/96)

PM factors - Generic (from AP42, Alaska rules, and Tier limits)

		EF	
ICE > 600 hp	0.0004 lb/hp-hr	0.05729 lb/mBtu	AP42 (Table 3.4-1, 10/96)
ICE < 600 hp	0.0022 lb/hp-hr	0.31429 lb/mBtu	AP42 (Table 3.3-1, 10/96)
ICE w / filters	0.0011 lb/hp-hr	0.15429 lb/mBtu	¹
ICE < 600 hp & Tier 2	0.00033 lb/hp-hr	0.04696 lb/mBtu	0.2 g/kW-hr
boilers		0.0236 lb/mBtu	AP42 (Table 1.3-1, 9/98)
incinerator		0.0035 lb/lb	AP42 (Table 2.1-12, 10/96)

¹0.05 gr/dscf PM limit. Method 19 with stack O₂ 12%, heat rate of 7000 btu/hp-hr, Fd = 9190 dscf/mmBtu.



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Shell Kulluk Emissions

DATE:

December 31, 2007

Emissions Summary for Screening Modeling Purposes

Stack Identifier			PM10		SO ₂		NOx	
			Max 1-hr		Max 1-hr		Max 1-hr	
Kulluk Stack No.	Comments		(lb/hr)	(g/sec)	(lb/hr)	(g/sec)	(lb/hr)	(g/sec)
1	K-1, 2, 11	K-1, K-2 at 100% cap., K-11 at 100%	3.1	0.39	10.4	1.32	151.1	19.06
	K-3, 4	Not used during drilling	0	0	0	0	0	0
	K-5, 6, 7	Electric, no emissions	0	0	0	0	0	0
2	K-8, 9, 10	Operating at 100% capacity	0.9	0.12	0.3	0.04	29.4	3.70
	K-12	Not used during drilling	0	0	0	0	0	0
3	K-13, 14	Operating at 100% capacity	0.7	0.09	0.2	0.0291	21.4	2.70
4	K-15, 16, 17, 18	Operating at 100% capacity	0.9	0.11	1.1	0.15	0.9	0.11
5	K-19	Operating at 100% capacity	1.0	0.12	0	0	0.4	0.05
Vladimir Ignatjuk			27.9	3.52	91.2	11.50	1566	197.44
Tor Viking II			8.1	1.02	27.6	3.49	108.8	13.73
OSR			6.4	0.81	15.0	1.89	233.4	29.44
Jim Kilabuk			0.3	0.04	1.1	0.14	24.1	3.03
Other engines shut down								
Maximum total when drilling			49.3	6.2	147.1	18.6	2135.1	269.3
							2049.718	



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Tim Martin

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Source Release Parameters for Screening Modeling Purposes**Rig Sources**

Source Description	Model Source ID	Source Type	Vertical or Horizontal?	Source Location		Rel Ht. ¹	Stack Dia.	Exit Temp.	Exit Vel.
				X(m)	Y(m)	(m)	(m)	(deg K)	(m/s)
Stack #1: 2 Main Engines / 1 Thrustmaster ^A	MAINENGs	POINT	horizontal	22.1	-30.0	10.52	97.1	672	0.001
Stack #2: 3 Crane Engines	DECKCRNS	POINT	vertical	49.0	-100.8	15.24	0.25	672	20.1
Stack #3: 2 HPP Engines	HPPENGs	POINT	vertical	84.7	-41.2	2.44	0.18	700	40.0
Stack #4: 2 Boilers / 2 Water Heater ^B	BOILHEAT	POINT	horizontal	24.6	-27.2	8.53	19.0	366	0.001
Stack #5: 1 Incinerator ^C	INCIN_K	POINT	horizontal	20.0	-32.0	10.52	45.7	623	0.001

^A Diameter and exit velocity adjusted since stacks emit horizontally.

Non-adjusted stack dia. is 1.67 feet (0.51 meters) and non-adjusted exit velocity is 36.6 m/sec.

^B Diameter and exit velocity adjusted since stacks emit horizontally.

Non-adjusted stack dia. is 0.5 feet (0.15 meters) and non-adjusted exit velocity is 16.1 m/sec.

^C Diameter and exit velocity adjusted since stacks emit horizontally.

Non-adjusted stack dia. is 1.5 feet (0.46 meters) and non-adjusted exit velocity is 10 m/sec.

¹ Above main deck which is 7.3 meters (24 feet) above the water surface.**Fleet Sources**

Source Description	Model Source ID	Source Type	Ship Type	Source Location ⁶		Rel Ht. ¹	Final Plume Rise Ht. (m)	Stack Dia. (m)	Exit Temp. (deg K)	Exit Vel. (m/s)
				X(m)	Y(m)	(m)				
Vladimir Ignatjuk ^{3,4}	VLADIMIR/BREAKERS	POINT/AREA	Primary Icebreaker	1499.9	-775.4	24.38	57.2	0.40	623	18.7
Tor Viking II ^{3,5}	TORVIKING/BREAKERS	POINT/AREA	Secondary Icebreaker	1499.9	-775.4	24.38	57.2	0.40	623	18.7
Oil Response Ships - Kulluk ²	OILSPILL	POINT/AREA	OSR Fleet	787.1	-64.0	15.24	43.4	0.18	700	40.0
Jim Kilabuk - Kulluk	KILABUK	POINT	Supply Ship	81.0	-19.0	15.24	---	0.18	700	40.0

¹ Absolute height above water.² To account for the movement of these vessels, the plume rise for the OSR fleet was determined by modeling the fleet as a point source.

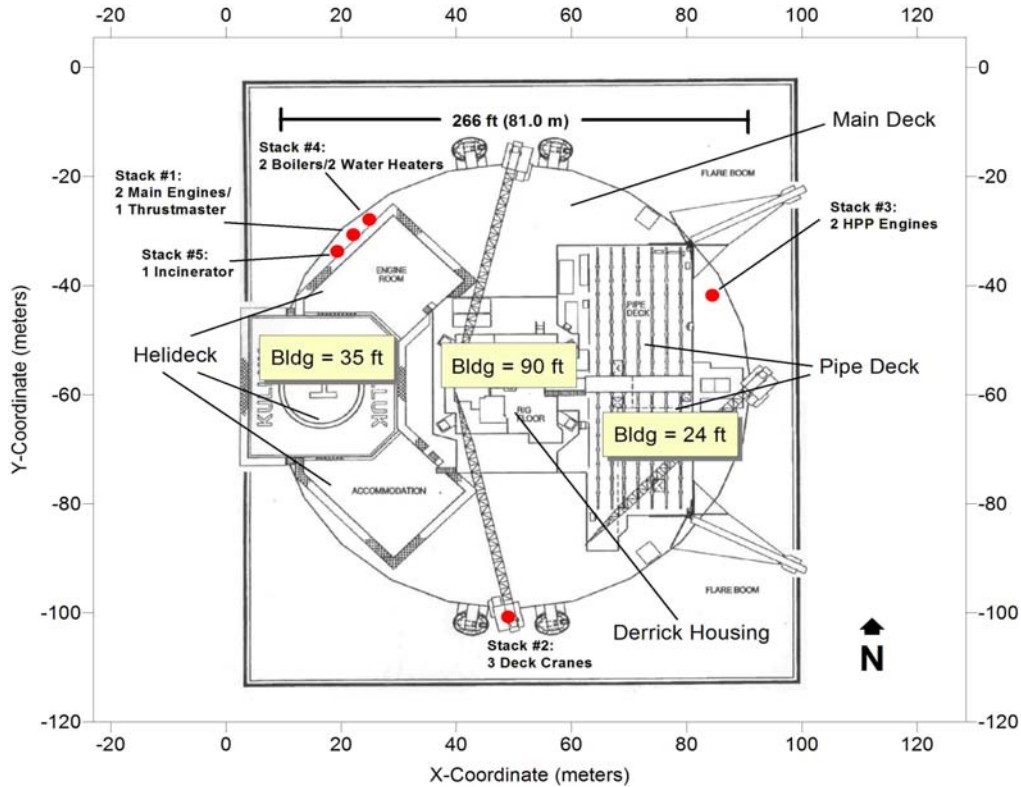
Then, the emissions for the OSR fleet were modeled as an elevated area source (based on plume rise) covering 1 square km (1,000,000 sq. meters);

final plume rise used for area source release height is 43.4 meters.

³ These sources are constantly moving to break ice upstream of the drill rig. To account for movement of the vessels, the plume rise for each icebreaker was determined by modeling each ship as a point source. Then, the emissions for each icebreaker were modeled as an elevated area source (based on plume rise) covering an assumed 3 km x 3 km ice management area for each ship.⁴ Assume Vladimir Ignatjuk ice management activity covers 9,000,000 sq. meters; final plume rise used for area source release height is 57.2 meters.⁵ Assume Tor Viking II ice management activity covers 9,000,000 sq. meters; final plume rise used for area source release height is 57.2 meters.⁶ For the area sources (ice breakers and oil spill response fleet), the source location is the southwest corner of the area source.

Configuration of Platform Equipment

* Building structure heights provided below are referenced above the main deck which is 24 feet above the water surface.





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Building Information for BPIP Analysis

Structure Name >	Helideck	Derrick Housing	Pipe Deck	Main Deck	Jim Kilabuk
Height Above Water >	17.68 m	34.75 m	14.63 m	7.31 m	13.72 m
# Structure Corners >	12	4	12	24	4
Structure Corner #	Coordinate X(m) Y(m)	Coordinate X(m) Y(m)	Coordinate X(m) Y(m)	Coordinate X(m) Y(m)	Coordinate X(m) Y(m)
1	29.1 -92.1	40.1 -48.7	68.4 -88.6	49.0 -17.0	78.0 -25.9
2	12.0 -75.3	40.1 -66.9	63.0 -88.6	59.6 -18.4	88.0 -34.9
3	12.0 -72.7	57.4 -66.9	63.0 -74.4	69.5 -22.5	98.0 -25.9
4	2.0 -72.7	57.4 -48.7	58.1 -74.4	78.0 -29.0	88.0 -15.9
5	2.0 -44.0	---	58.1 -32.3	84.5 -37.5	---
6	12.0 -44.0	---	80.6 -32.3	88.6 -47.4	---
7	12.0 -41.4	---	80.6 -54.7	90.0 -58.0	---
8	29.1 -24.8	---	89.6 -54.7	88.6 -68.6	---
9	43.6 -38.6	---	89.6 -62.9	84.5 -78.5	---
10	31.4 -51.0	---	80.6 -62.9	78.0 -87.0	---
11	31.4 -65.7	---	80.6 -82.3	69.5 -93.5	---
12	43.8 -77.6	---	68.4 -82.3	59.6 -97.6	---
13	---	---	---	49.0 -99.0	---
14	---	---	---	38.4 -97.6	---
15	---	---	---	28.5 -93.5	---
16	---	---	---	20.0 -87.0	---
17	---	---	---	13.5 -78.5	---
18	---	---	---	9.4 -68.6	---
19	---	---	---	8.0 -58.0	---
20	---	---	---	9.4 -47.4	---
21	---	---	---	13.5 -37.5	---
22	---	---	---	20.0 -29.0	---
23	---	---	---	28.5 -22.5	---
24	---	---	---	38.4 -18.4	---